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Statistical survey of scanning amplitudes and aspect ratios of domestic television receivers

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THE BRITISH BROADCASTING CORPORATION
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RESEARCH DEPARTMENT

STATISTICAL SURVEY OF SCANNING AMPLITUDES AND ASPECT RATIOS OF DOMESTIC TELEVISION RECEIVERS

Technological Report No. T-151

(1965/36)

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SUMMARY

Measurements have been made on a number of domestic television receivers, operating under normal home conditions, with regard to their settings of horizontal and vertical scanning amplitudes and aspect ratio. These measurements revealed that the accuracies of the adjustments made on installation, and the standard maintained by the receivers, in these respects, were somewhat better than had been expected and that, in general, domestic receivers are operated very much as intended by the manufacturers.

1. INTRODUCTION

It had been felt for some time that insufficient information was available regarding the proportion of the transmitted-picture area displayed by domestic receivers. This proportion depends upon the standards of adjustment maintained by dealers or rental companies with regard to picture size, aspect ratio and vertical and horizontal shifts.

With the advent of the 110° deflection angle, the aspect ratio of television picture tubes changed from approximately 4 : 3 to about 5 : 4, whereas the transmitted picture has an aspect ratio of 4 : 3. This means that if the horizontal scan is adjusted so that the left and right 'castellations' of a Test Card are just visible, there are unscanned areas visible at the top and bottom of the screen. Conversely, if the vertical scan is adjusted so as to fill the screen the tube must be overscanned in the horizontal direction by about 6%, in order to maintain a correct aspect ratio, and a small proportion of the picture area is not visible to the viewer.

How receivers are adjusted is of importance when, for example, the design of captions is considered; in some cases, the extremities of a caption may be lost to the viewer through receiver overscanning, etc.

A simple form of field-store standards converter has been proposed which incorporates only 3 1/3 ms delay units. If such a converter were used for exchanging programmes with the U.S.A., the effective picture size would be changed by about 17% in both the line and field directions. When converting from a 60 field standard to a 50 field standard the picture size would be reduced and would be surrounded by a blank border when displayed on a correctly adjusted receiver having an aspect ratio of 4 : 3.

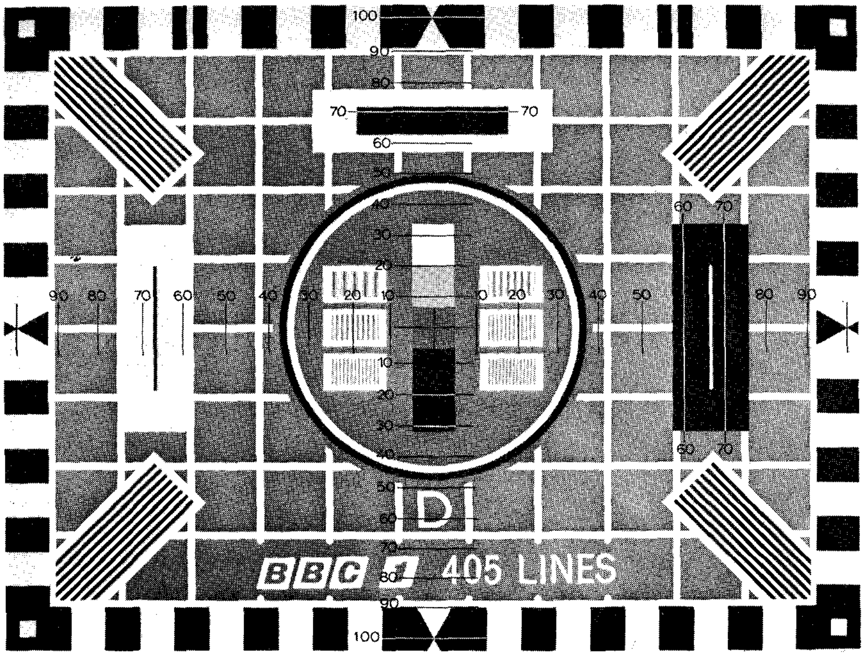

Fig. 1 - Test Card D calibrated in percentage of picture width and height from centre of circle

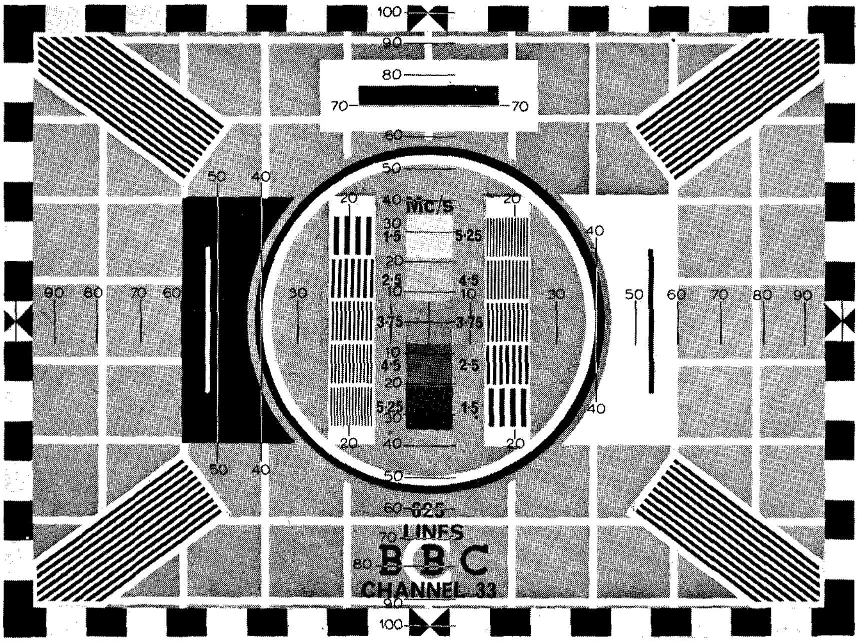

Fig. 2 - Test Card C calibrated in percentage of picture width and height from centre of circle

In the case of conversion from 50 fields per second to 60 fields per second, the picture would be, in effect, too large and its extremities would be lost to the viewer. It is obviously desirable to know whether the effects of receiver-scanning adjustment would be likely to mitigate or exaggerate the visibility of the error in picture size that would occur if conversion from 60 to 50 fields per second were carried out using the simple form of converter.

2. METHOD OF INVESTIGATION

Arrangements were made to visit a number of private homes where it was known that either 19 in. (482•5 mm) or 23 in. (584 mm) television receivers were available; the picture tubes all used 110° deflection angles and were therefore characterized by 5 : 4 aspect ratios. Most of these receivers were potentially capable of 625-line reception, none were more than about four* years old, and it was considered likely that they would be used for the next few years. It was further ascertained that the sets had not been adjusted other than by the dealers or rental companies who installed and maintained them; sets liable to receive special treatment (e.g. sets in the homes of television engineers) were not included.

By means of a Polaroid-Land camera and a simple jig a photograph was taken of each receiver screen when displaying Test Card 'D' on 405 lines and, when available, Test Card 'C' on 625 lines. In all, some 50 sets were photographed and about thirty of these included 625-line facilities.

Large scale photographs of Test Cards 'D' and 'C' (30 in. × 22•5 in.) (762 mm × 571 mm) were prepared and calibrated with a scale marked in percentages of the distance from the centre of the circle to the tops of the arrow heads in the centres of the castellated edges, as shown in Figs. 1 and 2. It was then possible to project, by means of an episcope, each photograph and to superimpose the image on the corresponding large calibrated Test Card. By registering the centres of the circles, and other features of the superimposed Test Cards, it was possible to measure accurately how much of the transmitted picture was displayed within the mask of the relevant receiver. Separate measurements were taken of the percentages of the picture dimensions actually visible between the centre of the circle and the top, bottom, left-hand and right-hand edges of the screen.

3. RESULTS

The results have been plotted as statistical frequency distributions in Figs. 3(*a*) to 6(*a*) for 405-line observations and in 7(*a*) to 10(*a*) for 625-line observations, and these results have been summed at 5% intervals in order to produce the histograms and smoothed curves of Figs. 3(*b*) to 6(*b*) (405 lines) and 7(*b*) to 10(*b*) (625 lines).

It will be seen from the statistical frequency distributions that the average 405-line viewer sees about 94% of the picture in the vertical direction and about 89% in the horizontal direction. However, in the case of the 625-line viewer the amount lost is a little greater, due to small differences in blanking time for which few receivers have compensation, and the average percentage visible is about 92% in the vertical direction and 88% in the horizontal direction. With a receiver correctly adjusted the viewer should see 100% vertically and 93•5% horizontally; this loss of 6•5% in the horizontal direction is due, as mentioned earlier, to the incorrect aspect ratio of the display-tube screen.

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* The first appearance of 19 in. (482•5 mm) and 23 in. (584 mm) receivers at the Radio Show was in 1961.

It is of interest to note that the majority of the results relating to the percentages of picture visible in the vertical direction appear to have two distinct peaks; one around 90% and one around 100%, whereas the results for percentages visible in the horizontal direction show single-peaked distributions. There was some possibility that the former might have been due to the limited number of samples. Statistical tests of 'goodness of fit' showed a very poor degree of fit when the results were compared with a single-peaked Gaussian distribution with the experimentally determined values of mean and standard deviation. When the experimental results were compared (using the χ^2 test) with an appropriate bimodal distribution, the 'goodness of fit' was much better, and was such that the probability that the observed distribution was bimodal and was 0•5. This probability is regarded as reasonably high and the bimodal hypothesis is probably true. What is much more certain is that a single-peaked distribution does not fit the experimental results (probability of fit for the single-peaked case is 0•002). It is therefore reasonable to assume that a bimodal distribution does in fact exist. A probable explanation is that those responsible for 'setting-up' these receivers, using a Test Card, decided that the castellations should be either wholly seen on the screen or completely eliminated by overscanning in the vertical direction. This would account for the comparatively small number of results obtained around the 95% point for the visible proportions of the dimensions from the centre to the top and bottom of the picture. On the other hand, the horizontal scan would normally be adjusted so that objects in the displayed picture such as the circle of a Test Card are, as far as possible, the correct shape. Many receivers however are only provided with limited facilities for this adjustment, i.e. a range of fixed settings instead of a continuously variable control, and this limits the accuracy to which width and aspect ratio can be adjusted.

Distributions and smoothed curves of the normalised aspect ratio are shown in Figs. 11 and 12 and, as would be expected, it will be seen that the same tendency to a bimodal distribution exists as in the histograms showing proportion of vertical picture dimension that is visible to the viewer. The normalised aspect ratio, shown as abscissae in Figs. 11 and 12, is defined as:

$$P = \frac{3}{4} \times \frac{5}{4} \times \frac{P_v}{P_h}$$

where P_v is the percentage of total available picture height that is actually visible to the viewer and P_h is the percentage of total available picture width that is actually visible to the viewer. It is unity when a picture with an aspect ratio of 4 : 3 is viewed on a correctly adjusted receiver having a 5 : 4 aspect ratio. The average is 0•98 for 405 lines and 0•995 for 625 lines and results from a slight bias toward overscanning in the vertical direction. Considering the picture as a whole, the average area of picture seen, ignoring the curvature at the corners of the screen and assuming a rectangular mask, would be about 84% in the case of 405 lines and 81% for 625 lines.

4. DISCUSSION OF RESULTS

The conclusion to be drawn from the results is that, although the geometry of the final picture, as seen by the viewer is usually acceptable, the method of 'setting up' seems to be arbitrary and more care could be taken to ensure that picture-size and aspect ratio are as near correct as possible.

When captions are being prepared for transmission the length of wording ought not to exceed 80% of the picture width if a significant number of viewers are not to miss information at the extremities.

With regard to the field-store standards-conversion arrangement mentioned earlier, it was stated that when the picture has been converted from a 60 field standard to a 50 field standard the viewer would be aware of a blank border surrounding the picture. Assuming a receiver is adjusted correctly this would amount to about 11% of the transmitted picture in the horizontal direction and 17% in the vertical direction, the difference being due to the 5 : 4 aspect ratio of the receiver cathode-ray tube. It may be deduced from Figs. 9 and 10 that the average 625-line viewer would be aware of blank borders to the left and right of the picture totalling 5% of the full transmitted picture width. This percentage of blank screen is, of course, divided more or less equally either side of the screen dependent on how well the picture is centred. In general, receivers were fairly well centred as far as the circle of the Test Card was concerned but of course there were departures from time-base linearity which would to some extent affect the symmetry of the blank border. It may also be deduced that approximately 10% of the viewers would be aware of blank borders totalling 12% or more of the picture width while a further 10%, due to the receivers being excessively overscanned, would have a picture filling the width of the screen.

However, from Figs. 7 and 8, the widths of the blank borders at the top and bottom of the picture displayed by the average receiver would total 9% of the picture height, but owing to the bimodal distribution some 30% of the viewers would see a total of 15% or more of blank border and less than 1% of the viewers would continue to see a picture filling the height of the screen.

The situation is very similar in the case of the 405-line viewer and again the blank areas will be more pronounced at the top and bottom of the picture than at the sides, due to the necessity for overscanning in the line direction in the receiver to achieve correct aspect ratio with a 5 : 4 cathode-ray tube.

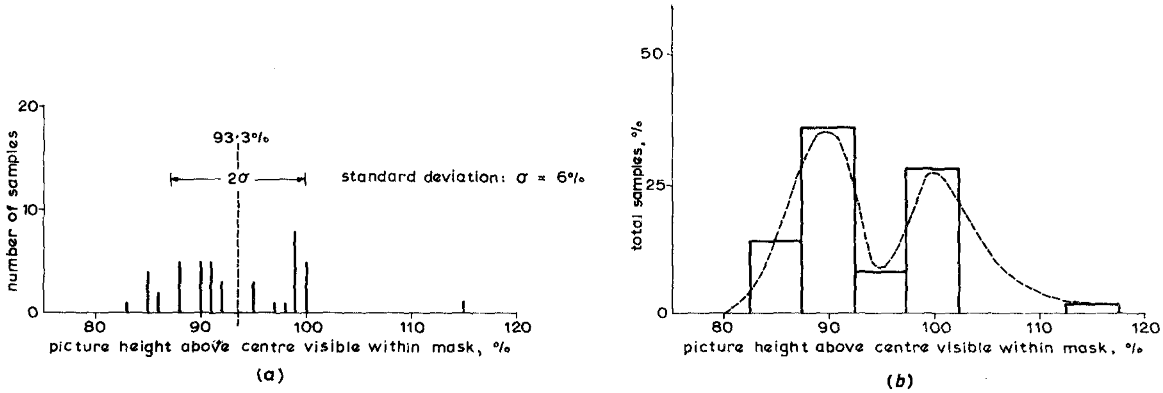

Fig. 3 - Statistical distributions (a) and histograms (b) of received images as functions of percentage of available picture height visible within mask on 405 lines BBC-1

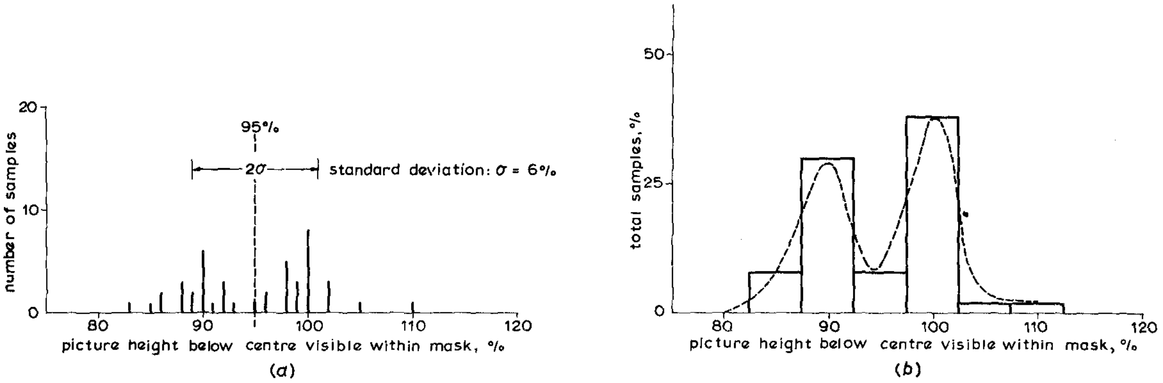

Fig. 4 - Statistical distributions (a) and histograms (b) of received images as functions of percentage of available picture height visible within mask on 405 lines BBC-1

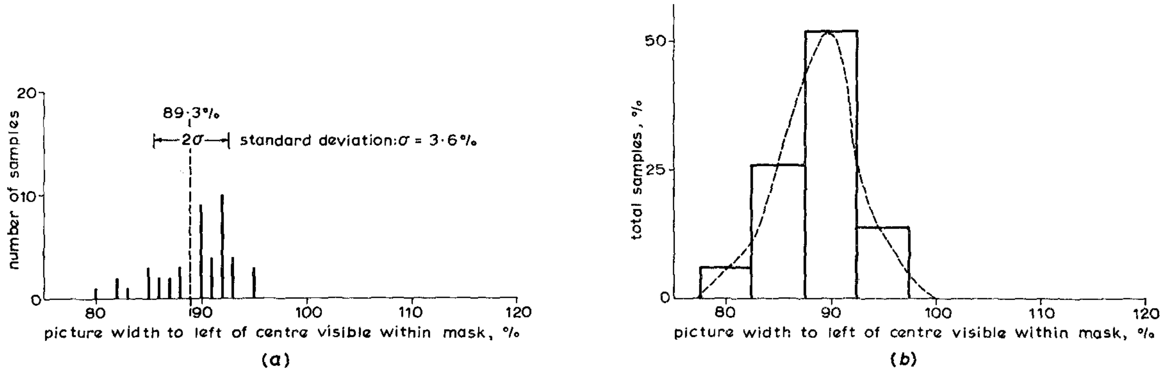

Fig. 5 - Statistical distributions (a) and histograms (b) of received images as functions of percentage of available picture width visible within mask on 405 lines BBC-1

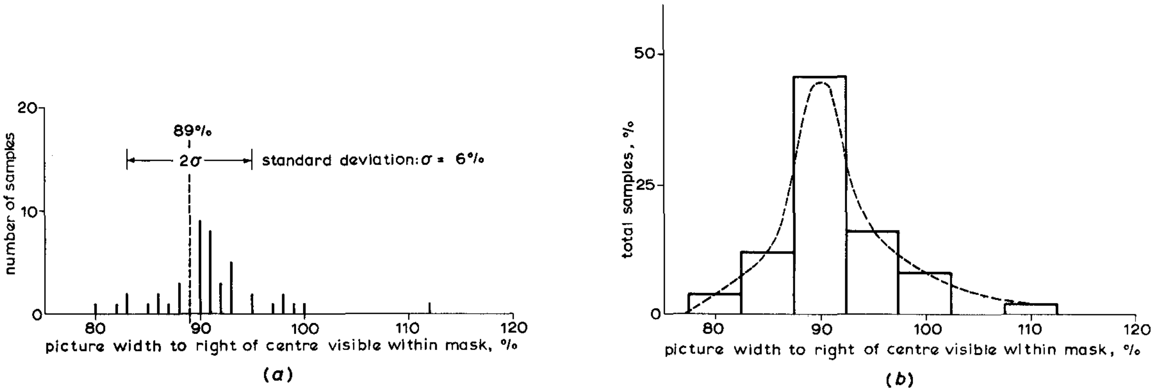

Fig. 6 - Statistical distributions (a) and histograms (b) of received images as functions of percentage of available picture width visible within mask on 405 lines BBC-1

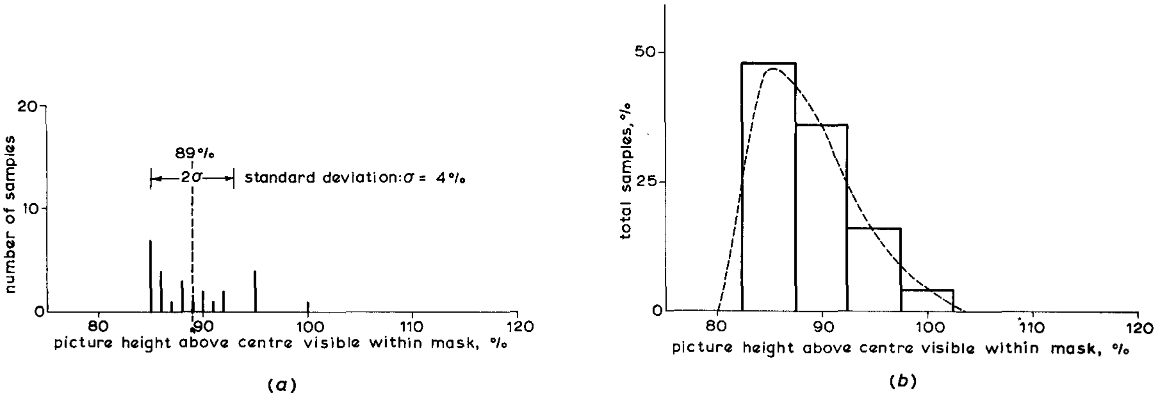

Fig. 7 - Statistical distributions (a) and histograms (b) of received images as functions of percentage of available picture height visible within mask on 625 lines BBC-2

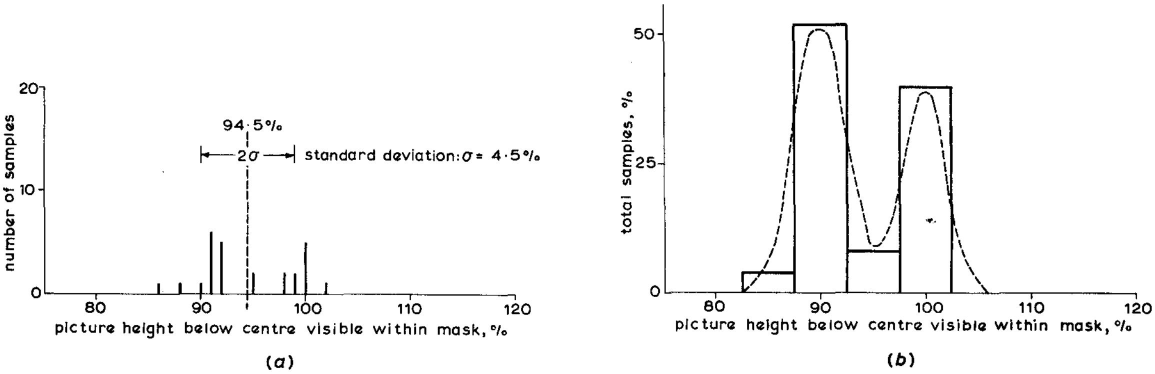

Fig. 8 - Statistical distributions (a) and histograms (b) of received images as functions of percentage of available picture height visible within mask on 625 lines BBC-2

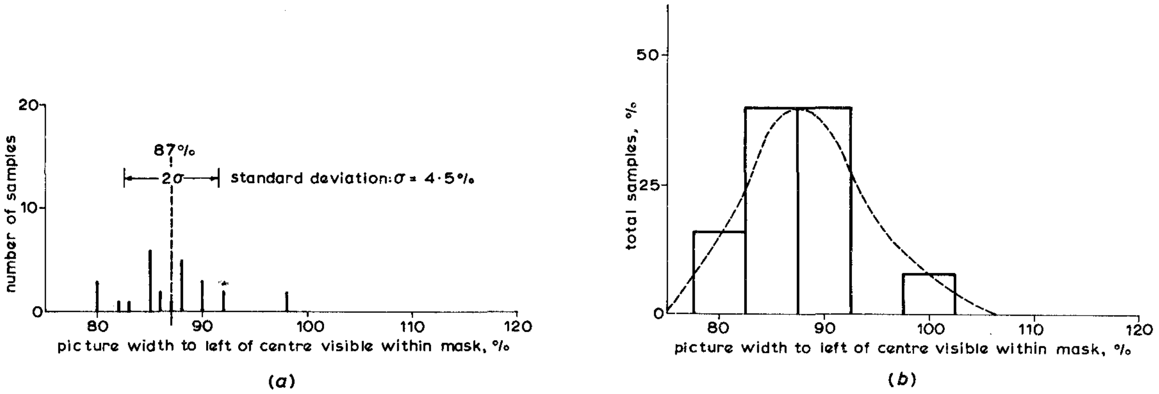

Fig. 9 - Statistical distributions (a) and histograms (b) of received images as functions of percentage of available picture width visible within mask on 625 lines BBC-2

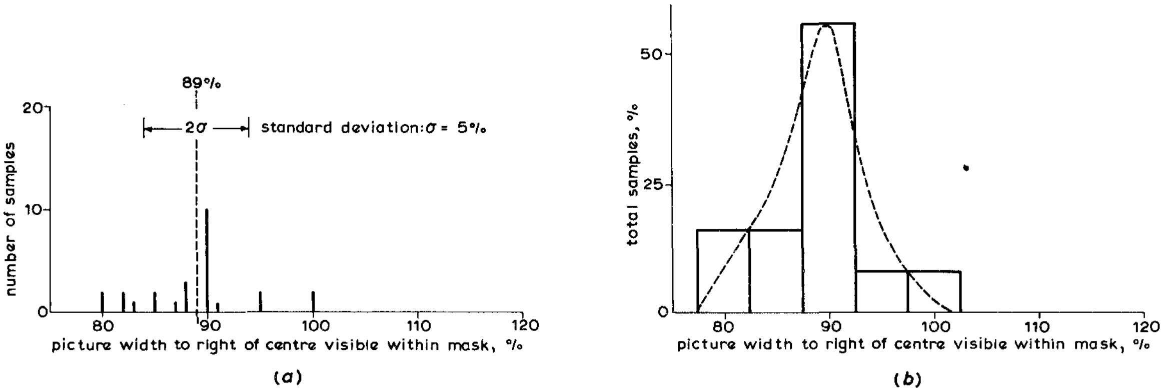

Fig. 10 - Statistical distributions (a) and histograms (b) of received images as functions of percentage of available picture width visible within mask on 625 lines BBC-2

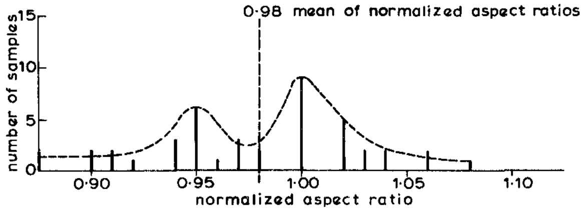

Fig. 11 - Histogram of normalized aspect ratio of received images on 405 lines BBC-1

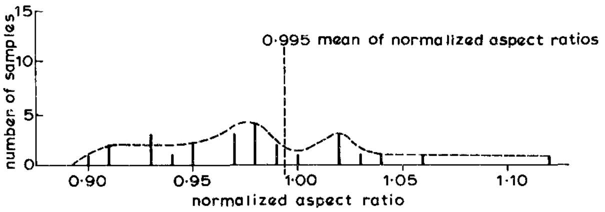

Fig. 12 - Histogram of normalized aspect ratio of received images on 625 lines BBC-2

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